MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2017/2018**

## EEM1026 – ENGINEERING MATHEMATICS II

(BE/ME/RE/TE)

3 MARCH 2018

9.00 a.m. – 11.00 a.m.

(2 Hours)

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**INSTRUCTIONS TO STUDENTS:**

1. This exam paper consists of 6 **pages** (including cover page) with 4 Questions only.

2. Attempt all the questions. All questions carry equal marks and the distribution of marks for each question is given.

2. Please write all your answers in the Answer Booklet provided. Show all relevant steps to obtain maximum marks.

3. Only NON-PROGRAMMABLE calculator is allowed.

## Question 1

(a) Show the following differential equation is not exact, find the corresponding integrating factor and obtain its general solution.

$$(2xy - x)dx - dy = 0$$

[11 marks]

(b) Consider the solution of $y'' + (3x+2)y = 0$ in the form of power series in $x$ about $x_0 = 0$, i.e., $y = \sum_{n=0}^{\infty} c_n x^n$. Find the first five coefficient terms of this series solution and display your answers in coefficients of $c_0$ and $c_1$ only.

[14 marks]

## Question 2

(a) Let

$$f(t) = \begin{cases} 1 & \text{if } 1 \le t < 2 \\ e^{-3t} & \text{if } 3 \le t < 4 \\ 0 & \text{otherwise} \end{cases}$$

Let $F(s)$ be the Laplace transform of $f(t)$. Evaluate $F(3)$.

[10 marks]

(b) Calculate the Fourier transform, $F(\omega)$ of the 'OFF-ON-OFF' pulse $f(t)$ defined by

$$f(t) = \begin{cases} 0 & (t < -2) \\ -1 & (-2 \le t < -1) \\ 1 & (-1 \le t \le 1) \\ -1 & (1 < t \le 2) \\ 0 & (t > 2) \end{cases}$$

[10 marks]

(c) Find the sequence $x[n]$ whose $z$ transform is

$$X(z) = \frac{z^3 + 2z^2 + 1}{z^3}$$

[5 marks]

**Continued...**

## Question 3

(a) Given the partial differential equation: $u_{xx} - 3u_{yy} = u$.

(i) By using the method of separation of variables, find the general solution for $u(x,y) = X(x)Y(y)$ for the case of separation constant $\lambda = 0$ only.
(Do not solve for $\lambda > 0$ or $\lambda < 0$)

[11 marks]

(ii) Hence, by using the solution from part (i), find the specific solution of $u(x,y) = X(x)Y(y)$ given that

$$u(1,0) = 3;\ u(2,0) = 12;\ u(0,\frac{\sqrt{3}}{2}\pi) = 5;\ \text{and}\ u(1,-\frac{3\sqrt{3}}{2}\pi) = 2.$$

[6 marks]

(b) Solve the equation $\frac{\partial u}{\partial x} + 7\frac{\partial u}{\partial t} = 0, \qquad u(x,0) = f(x).$

[8 marks]

## Question 4

(a) By using the method of undetermined coefficients, find the complementary function ($y_c$) and particular solutions ($y_p$) for the following inhomogeneous differential equations.

$$y'' + y' = 64e^x$$

[6 marks]

(b) According to a Pharmacy Report, Americans spent an average of \$220 per person on prescription drugs in 1994(*Kiplinger's Personal Finance Magazine, May 1996)*. A recent survey of 300 randomly chosen Americans revealed that they spent an average of \$235 per person on prescription drugs with a standard deviation of \$90. Test at 2.5% significance level whether the mean amount currently spent on prescription Drugs by all Americans exceeds \$220 per person.

[9 marks]

(c) Dr. Sim wanted to estimate the mean cholesterol level for all adult females living in Melaka. A sample of 25 females from Melaka have been studied and found that the mean cholesterol level for this sample is 5.7 with a standard deviation of 12. Assuming that the cholesterol levels for all females in Melaka are (approximately) normally distributed, construct a 95% confidence interval for the population mean $\mu$.

[5 marks]

(d) Based on a report, it was found that 92% of Singaporean drivers rated their driving as excellent. Suppose that this percentage was based on a random sample of 400 Singaporean drivers, find a 95% confidence interval for the corresponding population proportion.

[5 marks]

**Continued...**

## *APPENDIX*

**Table I: Laplace transform for some of function $f(t)$**

| $f(t)$ | $F(s) = \mathcal{L}\{f(t)\}$ |
|---|---|
| 1 | $1/s$ |
| $t$ | $1/s^2$ |
| $t^n (n = 1, 2, 3,\ldots)$ | $n!/s^{n+1}$ |
| $e^{at}$ | $\dfrac{1}{s-a}$ |
| $te^{at}$ | $\dfrac{1}{(s-a)^2}$ |
| $t^{n-1}e^{at}$ | $\dfrac{(n-1)!}{(s-a)^n}$, $n = 1,2,\ldots\ldots$ |
| $\cos at$ | $\dfrac{s}{s^2+a^2}$ |
| $\sin at$ | $\dfrac{a}{s^2+a^2}$ |
| $\cosh at$ | $\dfrac{s}{s^2-a^2}$ |
| $\sinh at$ | $\dfrac{a}{s^2-a^2}$ |
| $u(t - a)$ | $\dfrac{e^{-as}}{s}$, $a \geq 0$ |
| $f(t - a)\, u(t - a)$ | $e^{-as} L(f)$ |
| $f(t)\, \delta(t - a)$ | $e^{-as} f(a)$ |
| $f'(t)$ | $s\mathcal{L}(f) - f(0)$ |
| $f''(t)$ | $s^2\mathcal{L}(f) - s f(0) - f'(0)$ |

**Continued….**

## Table II: Table of Fourier Transform

| $f(x)$ | $F(w)=F\{f(x)\}=\dfrac{1}{\sqrt{2\pi}}\displaystyle\int_{-\infty}^{\infty} f(x)e^{-iwx}dx$ |
|---|---|
| $\dfrac{1}{x^2+a^2}\ (a>0)$ | $\sqrt{\dfrac{\pi}{2}}\dfrac{e^{-a\lvert w\rvert}}{a}$ |
| $H(x)\ e^{-ax}\ (\text{Re } a>0)$ | $\dfrac{1}{\sqrt{2\pi}}\dfrac{1}{(a+iw)}$ |
| $H(-x)\ e^{ax}\ (\text{Re } a>0)$ | $\dfrac{1}{\sqrt{2\pi}}\dfrac{1}{(a-iw)}$ |
| $e^{-a\lvert x\rvert}\ (a>0)$ | $\dfrac{1}{\sqrt{2\pi}}\dfrac{2a}{(w^2+a^2)}$ |
| $e^{-x^2}$ | $\dfrac{1}{\sqrt{2}}e^{-\frac{w^2}{4}}$ |
| $\dfrac{1}{2a\sqrt{\pi}}e^{-\frac{x^2}{(2a)^2}}\ (a>0)$ | $\dfrac{1}{\sqrt{2\pi}}e^{-a^2w^2}$ |
| $\dfrac{1}{\sqrt{\lvert x\rvert}}$ | $\dfrac{1}{\sqrt{\lvert w\rvert}}$ |
| $e^{-a\frac{\lvert x\rvert}{\sqrt{2}}}\sin\left(\dfrac{a}{\sqrt{2}}\lvert x\rvert+\dfrac{\pi}{4}\right)\ (a>0)$ | $\dfrac{1}{\sqrt{2\pi}}\dfrac{2a^3}{(a^4+w^4)}$ |
| $H(x+a)-H(x-a)$ | $\dfrac{1}{\sqrt{2\pi}}\dfrac{2\sin aw}{w}$ |
| $\delta(x-a)$ | $\dfrac{1}{\sqrt{2\pi}}e^{-iaw}$ |

**Continued....**

**Table III: Table of $z$- Transform.**

| $\{x_k\}$ | $F(z)$ |
|---|---|
| $e^{-ak}$ | $\frac{z}{z-e^{-a}}$, $\lvert z\rvert > e^{-a}$ |
| $a^k$ | $\frac{z}{z-a}$, $\lvert z\rvert > \lvert a\rvert$ |
| $ka^k$ | $\frac{az}{(z-a)^2}$ |
| $k^2a^k$ | $\frac{az(z+a)}{(z-a)^3}$ |
| $Z\{x_{k+1}\}$ | $z\,Z\{x_k\} - zx_0$ |
| $Z\{x_{k+2}\}$ | $z^2\,Z\{x_k\} - z^2x_0 - zx_1$ |

**End of paper.**